Dr. Robert W. Conn, Chair
Fusion Energy Advisory Committee
School of Engineering
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0403

Dear Dr. Conn:

In 1991, the National Energy Strategy (NES), following a recommendation of the Fusion Power Advisory Committee, defined the principal goal of the fusion energy program as "Prove fusion energy to be a technically and economically credible energy source, with an operating demonstration plant by about 2025 and an operating commercial plant by about 2040."

Since then, program funding has been inadequate to pursue the goal defined in the NES. Recognizing this situation, as part of the FY 1995 budget deliberations, Congress urged that a review of the fusion program be undertaken by the President's Committee of Advisors on Science and Technology. The review was completed in July 1995 and the Committee agreed that, while the DOE fusion strategy was reasonable and desirable, it was unrealistic in the current climate of budgetary constraint. The Committee recommended a program strategy funded at $320 million for each of the next ten years to preserve the most indispensable elements of the U.S. program and associated international collaboration. The Committee further stated that it was unable to envision a program that could preserve the key program priorities at a budget of $200 million per year.

Congress has now passed, and the President has signed, an appropriations bill providing $244 million for fusion, a reduction of almost one third below the FY 1995 level of $357 million. In the Conference Report accompanying that bill, Congress stated that there is "...little prospect for increased funding for the fusion base program over the next several years...," and we have had indications that funding might well be reduced further. Congress also directed the Department, working with the fusion community and the Fusion Energy Advisory Committee (FEAC), to prepare a strategic plan to implement a restructured program and provided some direction regarding the content of a restructured program. A copy of the Congressional language is enclosed (Enclosure 1).

As a first step, the Office of Fusion Energy, in concert with members of the community, has developed a draft strategy, defining a new mission for the fusion program. The reductions in current and projected fusion funding preclude us from implementing a program based on the goal set in the NES. The draft plan therefore redefines the fusion program from a schedule-driven, energy technology development program to a budget-constrained research effort aimed at reducing the size and cost of fusion reactors and advancing scientific knowledge on key fusion issues. The proposed mission of the new program is to establish a scientific knowledge base from which a fusion energy technology development program could be undertaken in the future, when appropriate. The draft strategy is also enclosed (Enclosure 2) for your review and comment, and Dr. N. Anne Davies will brief the Committee on it during your meeting.

In its deliberations on the restructuring of the fusion program, I want the Committee to consider the broader issue of plasma science that underpins fusion energy and has numerous applications in science, technology, and the commercial sector. Given the recent National Research Council report (Plasma Science from Fundamental Research to Technological Applications) recommendation that plasma science should receive increased funding, give us your views on how an expanded plasma science program might fit into a restructured fusion energy program.

In addition to your comments on the general strategy for the program, we need the Committee's help in planning the implementation of that strategy, including institutional considerations and the role of ITER and other international collaboration in the program. I would like FEAC to establish a Strategic Planning Subcommittee to assist in these tasks. Both FEAC and its Strategic Planning Subcommittee will require an unbiased assessment of the technical capability of the major U.S. fusion facilities and what they are able to contribute to the program's priority issues. FEAC will also require scientific assessments, based on analyses of experimental results, theory and modeling free of institutional bias, to inform future deliberations. I also want you, therefore, to establish a Scientific Issues Subcommittee, which will continue in existence beyond this particular charge, to provide scientific assessments that will inform the Committee's future deliberations, as well as the current ones.

I would like to have your recommendations on how to restructure the fusion program by mid-January. A set of questions to guide your deliberations is enclosed (Enclosure 3). I recognize that this is a very tight schedule but we need your advice in order to incorporate the restructured program in our FY 1997 budget request to the Congress. I look forward to meeting with you and the other FEAC members, and appreciate your willingness to address this important subject over such a short period of time.

Sincerely,

Martha A. Krebs
Director
Office of Energy Research

Enclosures

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A.DAVIES	I. ADLER	J. CLARK	J. DECKER	M.KREBS

Enclosure 1

Fusion Section of the Conference Report for the FY1996 Energy and Water Development Bill Congressional Record - October 26, 1995

Fusion

The conferees have provided $244,144,000, an increase of $15,000,000 over the House recommendation, for the fusion energy program. This funding is to support a program in plasma science and fusion technology, and continue United States participation in the engineering design activities phase of the International Thermonuclear Experimental Reactor project to which the United States is committed through fiscal year 1998. The conferees do not agree with the Senate language which recommended transferring computer work, termination, severance and separation costs to other activities within the Department, and transferring the heavy ion fusion program to defense activities.

With little prospect for increased funding for the fusion base program over the next several years, it will be necessary for the program to restructure its strategy, content and near-to-medium-term objectives. The restructured program should emphasize continued development of fusion science, increased attention to concept improvement and alternative approaches to fusion, and development and testing of the low-activation structural materials so important to fusion's attractiveness as an energy source.

The Department of Energy, with participation of the fusion community and the Fusion Energy Advisory Committee, is instructed to prepare a strategic plan to implement such a restructured program, to be completed by December 31, 1995. This plan should assume a constant level of effort in the base program for the next several years; as appropriate, it should be integrated with plans of the international fusion program; and it should address the institutional makeup of a domestic program consistent with the funding assumptions.

The conferees believe that, because of the stringent budget realities facing this Nation, the promise of fusion energy can only be realized through international collaboration. The high cost of fusion development points to the increasing importance of international cooperation as a means of designing, building, and financing major magnetic fusion facilities in the future. Because the United States has committed to such an approach, it is crucial that a restructuring of the fusion program maintain a strong domestic base and not undermine our credibility as a reliable international partner.

DRAFT: 11/29/95 Enclosure 2

Strategy for A Restructured U.S. Fusion Energy Research Program

Introduction

The Department of Energy's mission includes the development of fusion as one of the few long-term energy options with virtually unlimited fuel supply and favorable potential as a safe and environmentally attractive energy source. Under the reduced Federal funding envisioned for fusion, the U.S. Fusion Energy Program is being restructured to focus on fusion's underlying scientific foundations, including those technologies needed to enable scientific discoveries, and on fostering improvements in plasma confinement concepts in order to reduce the size and cost of future fusion power plants. Such a focus will also substantially strengthen the field of plasma science -a field in which the U.S. is the world leader and which has developed a variety of techniques widely applicable to other areas of science and technology. This revised strategy which focuses on the underlying science is a substantial departure from the Program's previous schedule-driven strategy aimed at operation of a demonstration power plant by the year 2025.

To accommodate reduced budgets for the foreseeable future, the Program must cut deeply into its considerable investments in human resources and facilities. In pursuing its new strategy, the Program will rely heavily on existing facilities, and will use the leverage offered by international linkages to contribute to and capitalize on the world fusion effort. Continued emphasis on innovation and the intellectual challenge of fusion will nurture the vitality and scientific richness needed to retain and attract the scientists and engineers required to accomplish this task.

Program Mission

Establish the scientific and technological foundations for an economically and environmentally attractive fusion energy source.

Core Values

The extraordinary challenge of fusion requires major advances in our knowledge of plasma physics, fusion technology and materials science. The development of the underlying fusion science and enabling technology, the foundation for such advances, is the single most important program element. A few examples among many topics requiring progress in understanding are plasma-wall interactions, plasma stability and transport, high-heat-flux alloys, and alpha-particle relaxation. Fusion research of the required quality depends upon: (i) the maintenance of a broad, vigorous talent pool, working in an intellectual environment that encourages creativity and innovation; (ii) effective connections to related scientific and engineering disciplines; (iii) a range of experimental facilities, including small devices for exploratory studies as well as larger facilities capable of approaching the physical conditions of a fusion reactor; and (iv) effective leverage of U.S. efforts through mutually beneficial international linkages.

Strategy

The issues of confinement concept optimization, burning plasma physics, and low activation materials remain fundamental to fusion research; they must be addressed by the restructured Program. The restructured Program will place a greater emphasis on concept optimization and a lesser emphasis on burning plasma physics, building on the significant accomplishments and valuable resources of the scientific program. Efforts on low activation materials will remain at a modest level compared to the other two. The issue of fusion power technology, including blankets and tritium handling, is also fundamental and must be addressed in the future as part of a fusion energy development program; this issue will not be addressed by the restructured Program except for small-scale efforts in selected key areas.

The three fundamental issues, associated objectives, and the approaches to addressing these issues in the restructured Program are discussed below. The objectives, while bold and challenging, can be pursued at a lower level of resources than was required for achieving the more ambitious goals of the previous Program strategy.

- Confinement Concept Optimization: Establish the scientific basis for one or more promising plasma confinement approaches that could lead to a significantly simpler, less expensive, and more reliable fusion energy source than one based on the present data base.

  Recent advances in understanding and performance that have been made with both tokamak and alternate plasma confinement approaches have illustrated the potential for major improvements in the attractiveness of fusion energy sources. The realization of this potential requires a broad-based fusion science and enabling technology program that fosters innovation and creativity. A two-pronged approach will be pursued: research to enhance the performance and attractiveness of tokamaks, conducted primarily through reliance on existing facilities, and expansion of the exploration of promising alternate plasma confinement approaches. Where appropriate, program activities will take into account the substantial fusion research investments being made and the innovative work being undertaken on alternate confinement approaches in Europe, Japan, and Russia. In addition, inertial confinement fusion is being pursued in the Department's Defense Programs, with a relatively small research effort on energy-specific enabling technology in the Fusion Energy Research Program.

- Physics of Burning Plasmas: Establish the scientific basis needed to understand and predict the behavior of burning plasmas under conditions relevant to a fusion energy source.

Exploring the many physics aspects of optimizing and sustaining burning Deuterium and Tritium (i.e., D-T) plasmas has been a major objective of the Program. In the near term, it is possible to address this objective experimentally for short pulses and moderate levels of alpha particle production in existing D-T devices. Important physics issues will also be addressed in the near-term by theory and by devices operating with plasmas that, while not D-T, simulate some of the phenomena in burning D-T plasmas. Given the constrained budget outlook for the Program, exploration of the physics of burning plasmas for long pulses and substantial alpha particle production can only be met through collaboration in broader international activities. As part of this, the Program will continue to participate in the International Thermonuclear Experimental Reactor (ITER) Engineering Design Activities (EDA). The Program will also seek to participate, even at a modest financial level, in the construction and operation of an international D-T plasma burning device as now embodied in ITER, in order to explore more thoroughly the physics of burning plasmas at high energy gain.

° Low Activation Materials for Fusion: Establish the feasibility of using low activation materials to significantly enhance fusion's potential as a safe and environmentally attractive energy source.

The materials surrounding a burning plasma must function in a demanding environment which includes high heat fluxes, substantial mechanical loads, and intense neutron bombardment. Development of compatible first-wall and blanket materials with low-activation characteristics is essential if fusion is to realize its full potential as a safe, economical, and environmentally attractive energy source. Because development of materials for the fusion environment requires a basic understanding of materials behavior under a combination of severe operating conditions, this is recognized as a long-term undertaking. This objective will be

accomplished through strong international collaboration on materials development based on fundamental research. It is expected to include a modest level of participation in an international materials testing facility to gain knowledge about the performance of materials in a characteristic fusion neutron environment.

Conclusion

In this revised program strategy, the focus of the U.S. fusion program has shifted from the operation of a demonstration power plant in 2025 to fostering improvements in confinement concepts and the underlying science and enabling technology of fusion. Human resources exist within the Program to support the new strategy and to contribute toward the world's fusion effort in many areas of critical need. The Program will require a range of national experimental facilities, from existing and new devices for exploratory studies, to larger facilities that can approach the operating conditions of a fusion energy source. Existing experimental facilities can address many of the Program objectives and provide information required for successful completion of the ITER EDA. The Program will continue to be an effective participant in the ITER EDA and will attempt to participate, even at a modest financial level, in the construction and operation of an international D-T plasma burning device as now embodied in ITER. Continued development of enabling technologies, support for theory and computational efforts, system studies, and use of international collaboration will permit the restructured Program to realize its vision.

Enclosure 3

Questions for the Fusion Energy Advisory Committee

What major science, technology, and policy goals should shape the U.S. fusion R&D program if it is funded at $200, $225, $250, and $275 million for the foreseeable future? In formulating your response, the Committee should consider the fusion research and development programs of other nations.

For each of these budget cases:

- Does the proposed strategy that has been developed by the Department and the fusion energy community meet these goals? How would the program be optimized if funded at each of these levels?

- What R&D elements would the Committee recommend preserving within a restructured fusion program?

    - What special capabilities do we have that should be emphasized to stay at the forefront of this or related fields?

    - What are the areas of strength in the U.S. fusion program which should be emphasized in order to maximize our attractiveness as a partner in international collaborative activities?

- What is the appropriate level of U.S. participation in the International Thermonuclear Experimental Reactor project?

- What should be the balance of research and technology effort among universities, federal laboratories, and industry within a restructured program? Should the program consolidate its activities among fewer performers? If so, how should the program go about doing this?